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Algae and flowering aquatic plants (submergents, floaters and emergents) form the first link in the food chain, contribute to the water environment by taking in CO_2 and releasing O_2 during photosynthesis, provide an animal habitat for the water community, and control erosion. But even with these necessary contributions, certain species have the ability to become major world wide aquatic pest plants. Shallow depth, gently sloping shorelines,

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stable bottoms, warm water, clear water, and water of high fertility are environmental factors that contribute to dense aquatic plant growth. Nitrogen and phosphorus compounds discharged from sewage plant effluents, home waste disposal systems, food-producing plants, and well-fertilized agricultural watersheds increase fertility thereby stimulating profuse growth of algae and aquatic plants. Also, seed production, vegetative reproduction and winter buds intensify the problem.

Excessive growths interfere with swimming, boating and fish propagation; clog intake pipes; make water unfit to drink without treatment; cause oxygen depletion and subsequent fish kills due to increased respiration and decomposition; and speed up the natural lake filling processes.

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AQUATIC PLANT MANAGEMENT FOR RECREATION AREAS

INTRODUCTION

The uses and management objectives for a body of water determine, to a large extent, the need for management control of aquatic plants. A given body of water may be used for fishing, boating, swimming, water skiing, and/or hunting, and aquatic plant control may be required to meet the objectives of domestic, industrial, recreational, or agricultural use of the water.

Floating and submerged plants can interfere with swimming or boating. In fact, dense growth of plants can make swimming hazardous. Swimmers are not attracted to murky water, such as is caused by the proliferation of algae. Rooted emergent plants along the shoreline may make it difficult to launch boats and may limit the usefulness of beach areas. Dense vegetation also interferes with fish propagation, hatchery operations, and fishery management. Aquatic plants may give water an off-flavor or fishy odor and make it unfit for drinking without treatment. Free-floating aquatic vegetation often clogs irrigation pipes and nozzles and some aquatic plants may restrict industrial withdrawals of water.

Aquatic plants may also be desirable for special purposes. Certain plants and their seeds are useful as cover and food to attract waterfowl for fall hunting. If fishing is a major interest, a limited number of aquatic plants--both floating and submerged--may be desirable. They provide fish with cover, food, and a spawning site. When they are overabundant, they interfere with fishing and fish life.

The desirability of aquatic plant growth depends on the water use. Reservoir managers and swimmers want clean, clear water that is free of weeds, algae, and other organisms. Waterfowl hunters want an abundance of aquatic plants that attract ducks and geese. Anglers like lily pads, weed beds, and plankton that nurture fish, but not if they become widespread and spoil the fishing. Conservationists strive for suitable plant cover on watersheds and banks of streams, lakes, and ponds to control erosion and to protect water quality. It is clear that the owner or manager of a body of water should be knowledgeable about aquatic plants so that he can choose procedures to meet his management objectives. (1-5).

GROWTH OF FLOWERING AQUATIC PLANTS

The most conspicuous aquatic plants belong to the flowering group. They can be divided into three categories based on the depth of water in which they grow: submergents, floaters (attached or unattached), and emergents.

Submergent aquatic plants are found in deep water and are usually attached to the bottom. Generally they are found entirely under water except for some species which, at flowering time, may protrude a short distance above the surface where the action of wind and insects aid in the pollination of flowers. After pollination, flowers and stalks withdraw to below the surface where the fruits mature. Pondweeds, waterweeds, coontails, and water milfoils are among the common submergents. Many have roots that are simple and delicate, used only for anchoring plants. The nutrients required for growth are obtained from surrounding water.

Floating aquatic plants are found in shallow water. Some, such as water lilies, watershield, and spatterdock usually are rooted in the mucky bottom and absorb their nutrients from the bottom mud. The leaves and flowers either float or are raised slightly above the surface, and the flowers are pollinated by insects. Thick masses of floating leaves reduce light penetration to the bottom, thus limiting the growth of submerged plants below. Unattached floaters, such as the duckweeds, obtain their nourishment from the water. Wolffia, the smallest of the aquatic flowering plants, may grow in clusters and have a single leaf about the size of a pinhead.

Emergent aquatic plants grow along the shoreline in shallow water and are sometimes called marsh plants. Their roots, imbedded in the bottom of the pond, obtain mineral nutrients from the soil. Their stems, leaves, and flowers protrude well above the water line. Emergents include the cattails, arrowheads, rushes, reeds, and sedges. These may grow in moist bog locations or in water up to several feet deep. Spear-like, grass-like, or arrow-shaped leaves are found on many of the aquatic plants in this group. The variation in leaf form, which is related to water depth, sometimes makes identification of certain emergents difficult. For example, the leaves on the same species of arrowheads may vary from straight, spear-like blades to broad, arrow-shaped blades.

Reproduction

Some plants reproduce from seeds that fall into the water and are carried by currents or birds to new aquatic locations. Other seeds may be

disbursed by the wind. Some seeds germinate immediately, while others remain in the bottom mud for years before germinating.

In addition to seed production, many aquatic plants also reproduce vegetatively by runners and fragmentation. Species that reproduce by fragmentation present a peculiar problem in control. Mechanical methods of removal, such as cutting and raking, should not be used. If an underwater mowing machine is employed, fragments of the mowed plant float with the current and may grow new roots, anchor, and thrive in another area. The problem is intensified instead of being eliminated.

Winter buds, or turions (coontail and pondweed) in the late summer and fall are a method of reproduction for some species of submerged plants. The winter buds preserve the plant through the rigorous cold season.

Effects of Environmental Factors

Environmental factors which inhibit growth are deep water, steep shoreline slopes, unstable bottoms, cold water, colored or turbid water, and water of low fertility. In contrast, lakes or ponds that are subject to dense aquatic plant growth usually have two or more of the following characteristics: shallow depth, gently sloping shoreline, stable bottoms, warm water, clear water, and water of high fertility.

Soft water has a low mineral content and is generally low in fertility. Ponds or lakes of this nature often have sparse vegetation composed of pondweeds, bladderworts, water lillies, and some species of milfoils. Hard water usually has a high mineral content and a correspondingly high fertility. Ponds of this type often support a dense growth of many different species.

Fertility of soft water impoundments may be increased through drainage from fertilized fields, feedlots, or barnyards. Nutrients also may be brought in by effluent from septic tanks and other waste disposal systems. The bottom soil in lakes and ponds influences the number and species of plants that will grow. Most aquatic plants grow best on a mixture of sand and organic soils. (6-12).

GROWTH OF ALGAE

Algae are the most common and most uniformly distributed of all aquatic plants. Most waters contain many species, including representatives of the green, blue-green families, as well as the filamentous and stonewort types.

Filmentous Algae. Many algae, when they occur in masses, can be seen without a microscope. Some appear as thick, filamentous mats, often called pond scum. Others may form a green, fur-like coating on stones and other bottom objects.

Plankton Algae. All suspended forms of algae make up part of the great number of small plants and animals known as plankton. Plankton algae are the most important plants in all natural bodies of water. These microscopic plants utilize carbon dioxide, water, and sunlight to manufacture carbohydrates and other energy chemicals. Thus, they serve as the beginning of the food chain which supports most higher forms of aquatic life. In large numbers, plankton algae may color the water brown, yellow, pea-soup green, or even red during the warm seasons of the year. When this occurs, the lake or pond is said to be "working". These blooms may indirectly provide food for fish, but they may also make water undesirable for swimming or fishing, or for use as a domestic water supply. Each ounce of water in this condition contains millions of microscopic algae cells.

Stonewort Algae. Another type of algae, the stonewort or muskgrass, has a strong, musky odor, and stonewort is sometimes encrusted with calcium deposits which give a rough, gritty texture. These plants consist of an erect, central main stem from which sprout clusters of branches at various intervals. They may grow as tall as 2 or 3 feet, and can completely cover a pond or lake bottom. Because of their size and growth, these species of algae may be mistaken for flowering plants. (1, 2).

CONTRIBUTION OF PLANTS TO AQUATIC ENVIRONMENTS

Energy

Aquatic plants, like all other green plants, use energy from the sun to manufacture carbohydrates. Part of the energy obtained is essential for the growth of the plant itself. The excess energy is stored in the form of carbohydrates, oil, and other products. It is this stored energy that supports most other organisms in aquatic environments. Submerged aquatic plants contribute to the water environment by taking in carbon dioxide and releasing oxygen during photosynthesis.

Food Chain

Algae and flowering aquatic plants form the base of the food pyramid, or the first link in the food chain. These plants are called producers, and must be presented in great abundance to support the aquatic animal population, termed the consumers. Organisms that feed directly on these plants are called primary consumers. Part of the energy transferred to the consumer through food is used in its own growth, and the excess is stored. The primary consumer is eaten in turn by the secondary consumer, and so forth as the cycle of energy utilization and storage is repeated up the

food pyramid. As the food pyramid becomes taller, or the food chain longer, fewer individual organisms can be supported.

The stems and leaves of the submerged parts of flowering plants serve as host for a whole community of microscopic organisms, all of which contribute to the food chain of the pond or lake. Bacteria, fungi, algae, diatoms, protozoans, insect larvae, thread worms, bristle worms, rotifers, and small crustaceans are the principal members of the community of organisms that live on and around the larger plants. The population of this community is spread over all leaf and stem surfaces. Increasing in numbers until the end of the summer, this microscopic community provides support for the larger organisms including fish.

Animal Habitat

The underwater plants contribute in another way to the ecological structure of the total pond or lake community. Many of the free-living and swimming organisms, such as fish and amphibians, use plant beds as places to deposit eggs. The young of many fish use these beds for shelter from predators, or they seek the plants as a feeding area since a rich supply of food organisms is usually available there.

Pondweeds, arrowheads, bulrushes, and reeds are important foods for wildlife. The snapping turtle's diet consists of nine-tenths vegetable matter; plants make up two-thirds of the food for the smaller painted turtle. Muskrats eat the rootstocks, tubers and stems of emergent plants, including cattails, arrowheads, bulrushes, and water lilies.

Filling

In the course of thousands of years, a pond or lake will fill and become dry land. The deeper the lake, the longer it will take to fill.

This filling process is aided by the growth of aquatic plants in several ways. The continued cycle of plant growth and decomposition creates a slow building up of organic matter in the basin. Plants also retard the flow of water and thereby cause suspended material to settle to the bottom. As the filling progresses, plants of the shallower zones become established in the former deeper zones. Most bogs and swamps are lakes that are being filled by these processes.

Water Pollution

Pollution associated with aquatic plant growth may be of two types: pollutants which inhibit growth and those which stimulate growth. Although both forms can be serious, this discussion is developed primarily around the growth-stimulating pollutants.

The chemicals that stimulate growth are mainly nitrogen and phosphorus compounds that discharge from sewage plant effluents, home waste disposal systems, food-producing plants, and well-fertilized agricultural watersheds. These material stimulate profuse growth of both algae and flowering aquatic plants.

Depending on conditions, a polluted pond or lake may be either excessively turbid and scum coated or clear and choked with weeds. Either condition indicates water relatively high fertility and optimum conditions for algae or for larger plants. These conditions are often created by wastes from housing subdivisions, cabins, and cottages. Sewage effluent from these installations reaches the stream and lakes of the local watershed. Sewage treatment or disposal systems that meet governmental requirements may not circumvent the problem of increased fertility;

nitrates and phosphates remaining is treated sewage stimulate plant growth in receiving waters.

Dense aquatic plant growth may cause oxygen depletion and subsequent fish fills. Warm, calm, and cloudy weater in summer and thick, opaque or snow-covered ice in winter contributes to this hazard. Under these conditions, plants do not photosynthesize and produce oxygen. Instead, they only respire and consume oxygen and some may die and decompose. Organic decomposition occurring throughout the year, makes a continuous demand upon available oxygen. If oxygen is not available through wave action, inflowing water, or photosynthesis, oxygen levels may be reduced to levels inadequate for fish and many of their food organisms. (13-15).

OBNOXIOUS AQUATIC PLANTS

Certain species have reached that position in the ecological succession to be considered as major world wide aquatic pest plants. The factors associated with population density and water pollution generally are key inputs in any system which allows for the development of a single dominant aquatic plant species. Control of these plants when they reach the problem-stage, regardless of the cause, usually requires massive efforts. Herbicides that have the possibility of being used on such plants, preferentially should have the characteristic of rapid degradation of both parent and subsequent metabolites.

Floating species such as water hyacinth and water fern are the most widely distributed aquatic pests. Submersed species, hydrilla, potomageton and Eurasion milfoil are world wide in distribution, but usually are regional in importance.

Marsh grasses, typha and phragmites are the dominant rooted marginal plants with world wide importance.

There does exist in every plant the possibility of becomming a major aquatic pest. This can be a regional problem or it can in time become national if the localized initial infestation is not controlled.

SUMMARY AND CONCLUSIONS

Algae and flowering aquatic plants (submergents, floaters and emergents) form the first link in the food chain, contribute to the water environment by taking in CO_2 and releasing O_2 during photosynthesis, provide an animai habitat for the water community, and control erosion. But even with these necessary contributions, certain species have the ability to become major world wide aquatic pest plants. Shallow depth, gently sloping shorelines, stable bottoms, warm water, clear water, and water of high fertility are environmental factors that contribute to dense aquatic plant growth. Nitrogen and phosphorus compounds discharged from sewage plant effluents, home waste disposal systems, food-producing plants, and well-fertilized agricultural watersheds increase fertility thereby stimulating profuse growth of algae and aquatic plants. Also, seed production, vegetative reproduction and winter buds intensify the problem.

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